National Defense Center for Energy and Environment

TARDEC Occupant Protection Seat

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Presentation Overview

- Objective
- Program Overview
- Seat Design Overview
- Subscale Energy Attenuation (EA) Testing
- Phase II Design Updates
- Seat Fabrication Progress
- Remaining Work

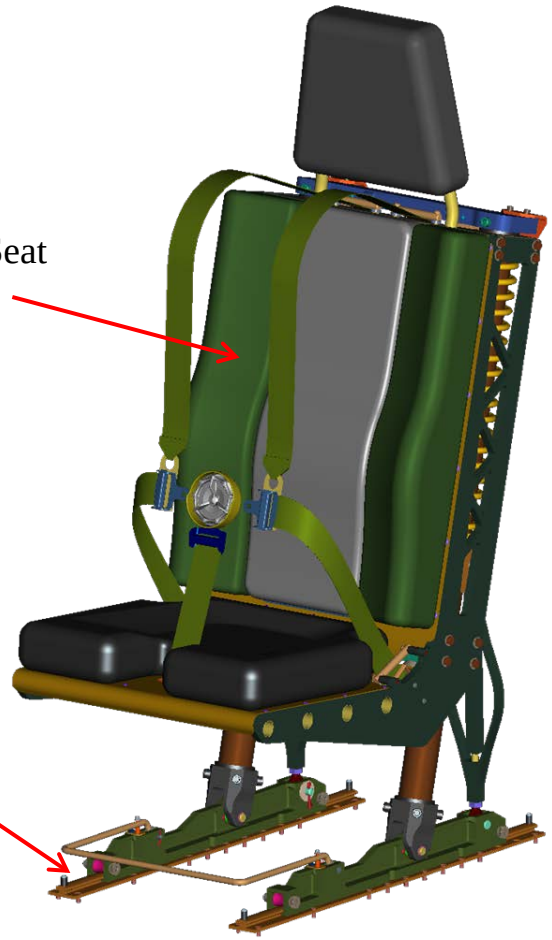
Objective

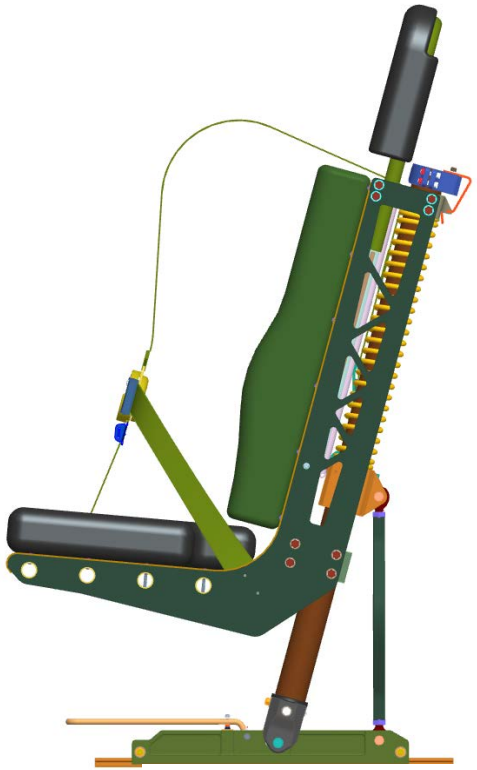
- To develop an innovative, robust blast mitigating seat design that maximizes occupant safety during blast, slamdown and crash events.
  - The NDCEE blast mitigation seat design utilizes a robust wire bender Energy Attenuation (EA) system with a reset mechanism that protects the occupant during both the upward blast acceleration and slam down deceleration events.

Program Overview

- Phase 1 (November 2010 - December 2011)
  - Develop requirements
  - Develop EA system design / finite element analysis (FEA)
  - Design / build / test a subscale EA test fixture to verify EA performance and correlate with FEA models
  - Complete seat design to CDR level (CDR held 22 Dec 2011)
- Phase 2 (November 2011 - Present)
  - Update seat design to optimize performance based on test results
  - Fabricate four (4) prototype seats for testing
  - Perform drop tower testing to evaluate seat performance
  - Perform blast testing to evaluate seat performance

Design Overview

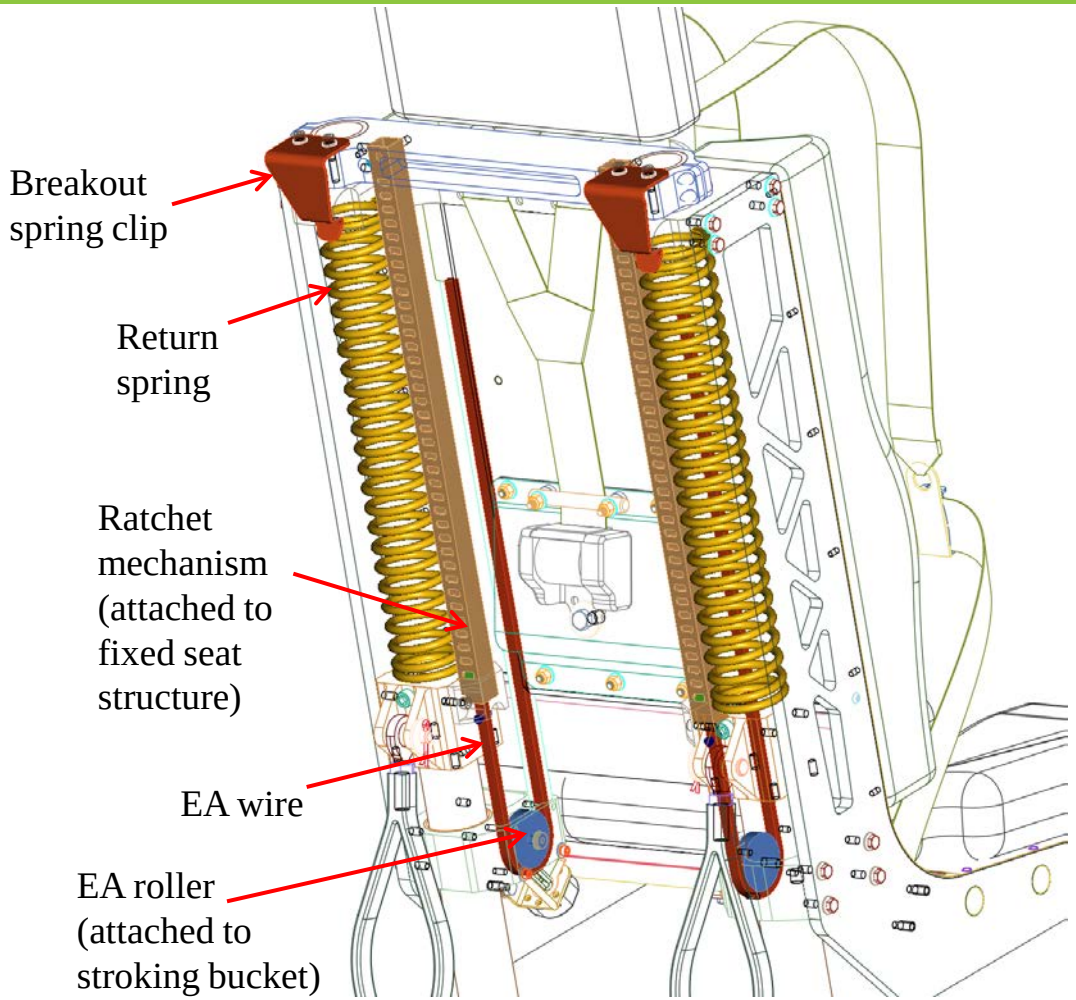




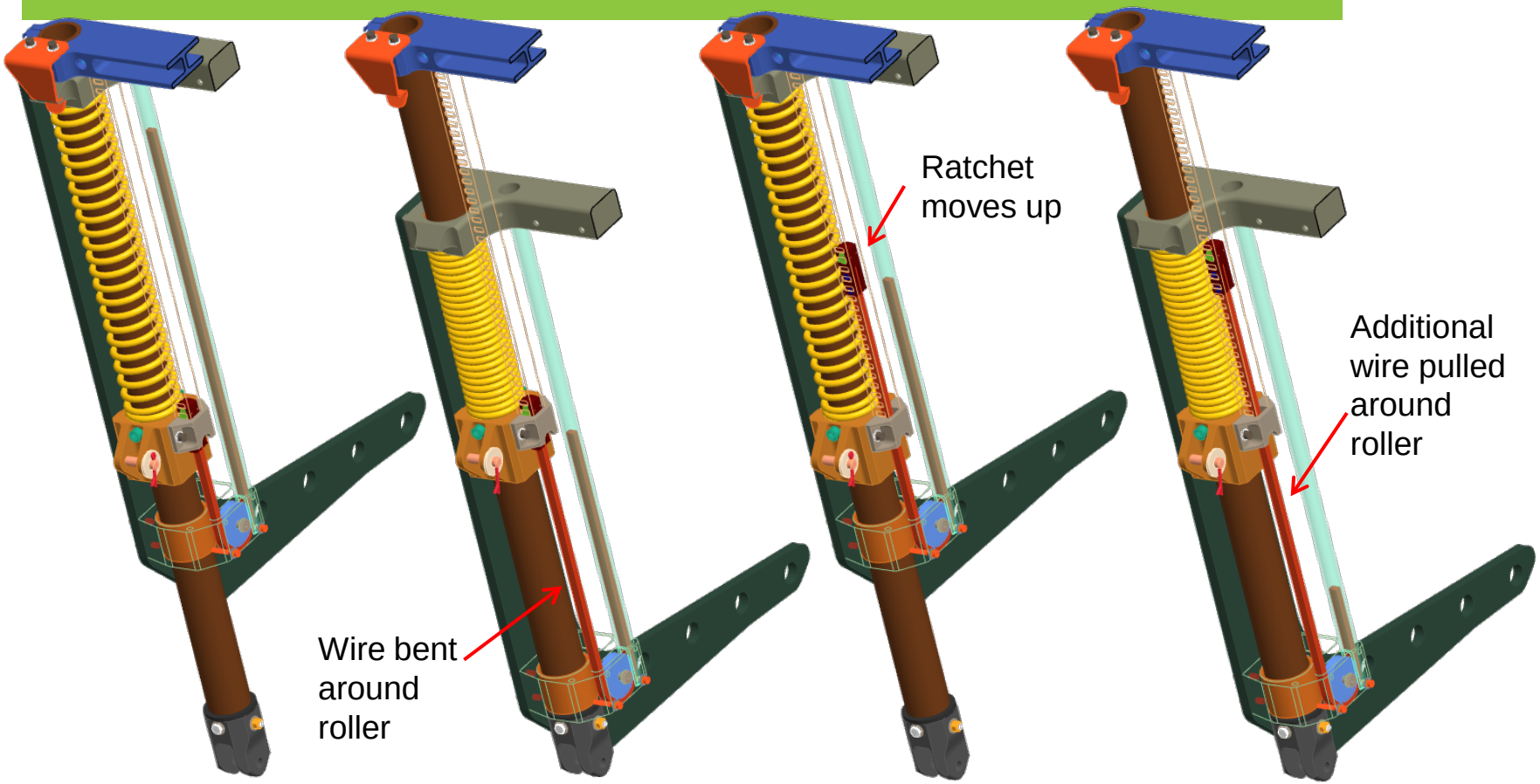
Nominal position

Stroked 8 inches

Design Overview – EA System



Design Overview – EA System



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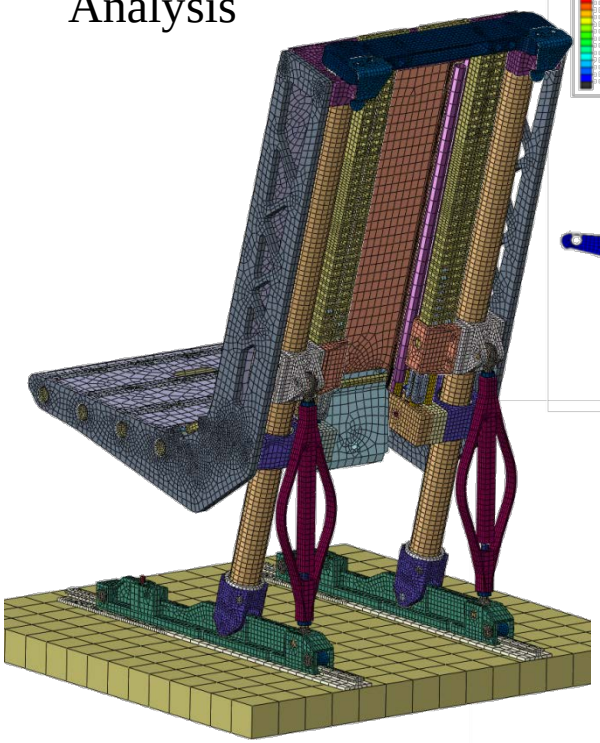
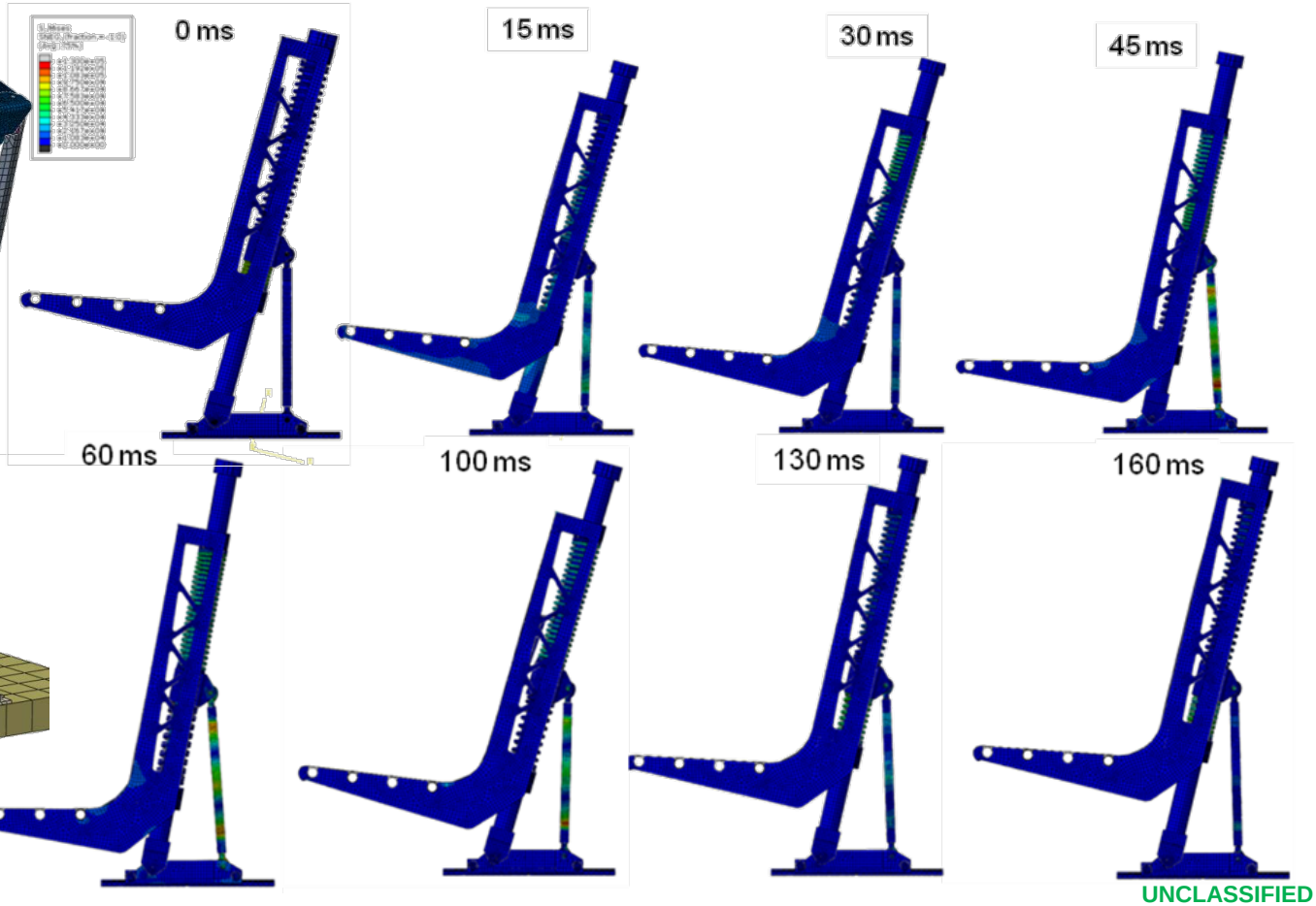
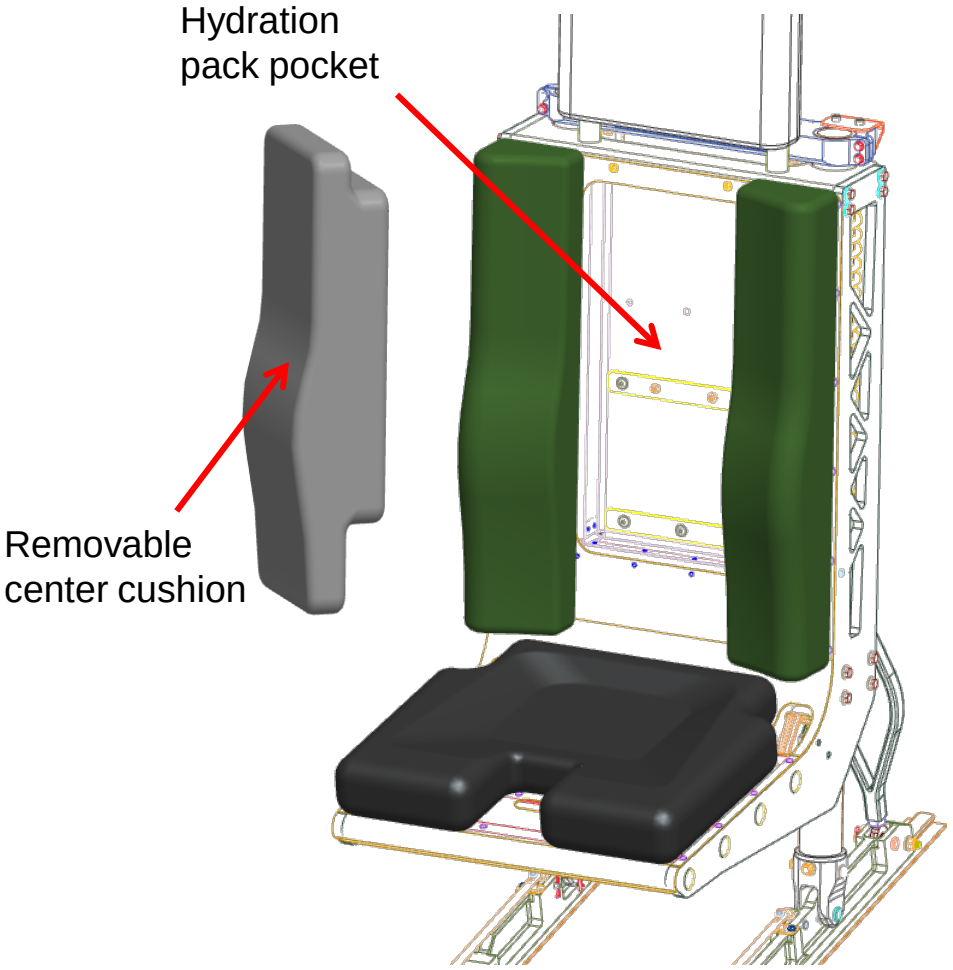
EA System FEA

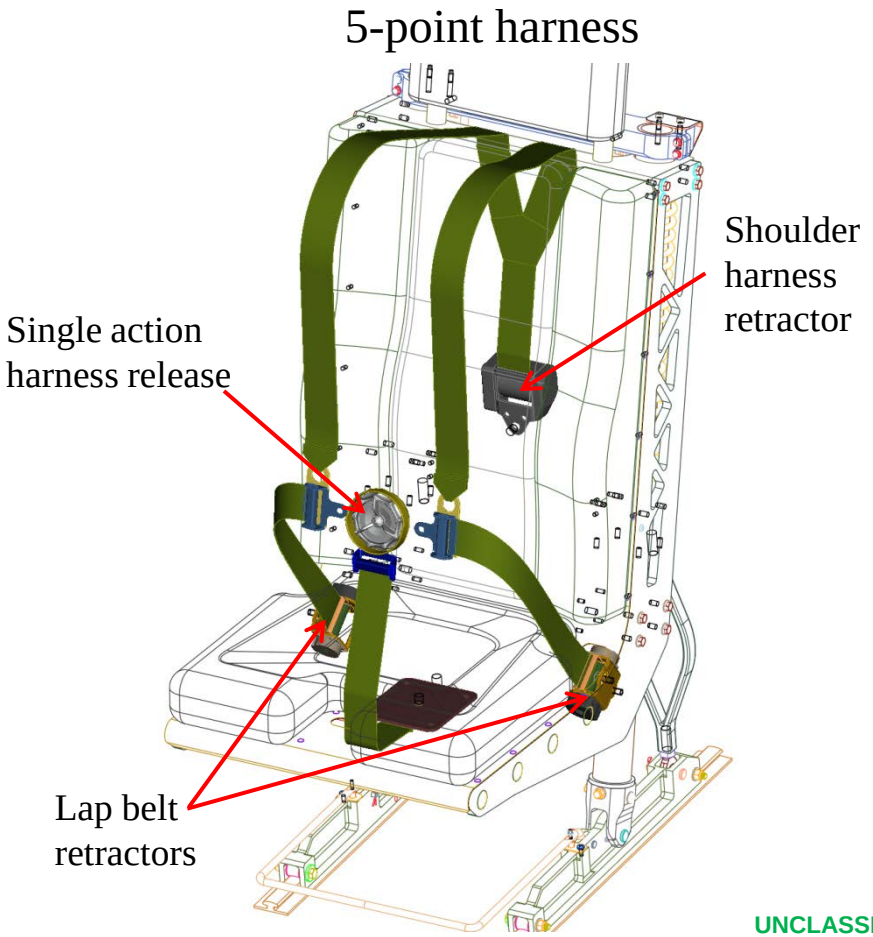
ABAQUS Explicit Analysis



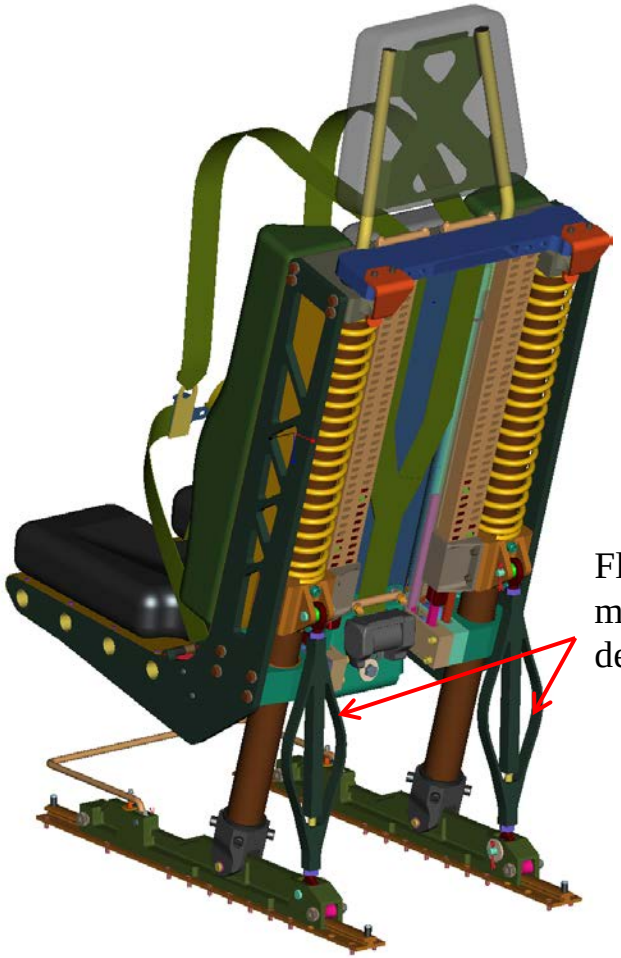


Design Overview – Cushions / Harness



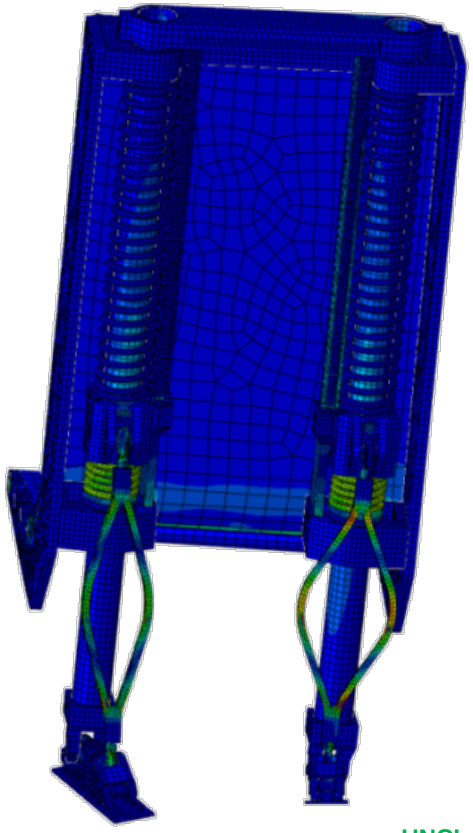


Design Overview – Floor Deformation



Flexible links to mitigate floor deformations

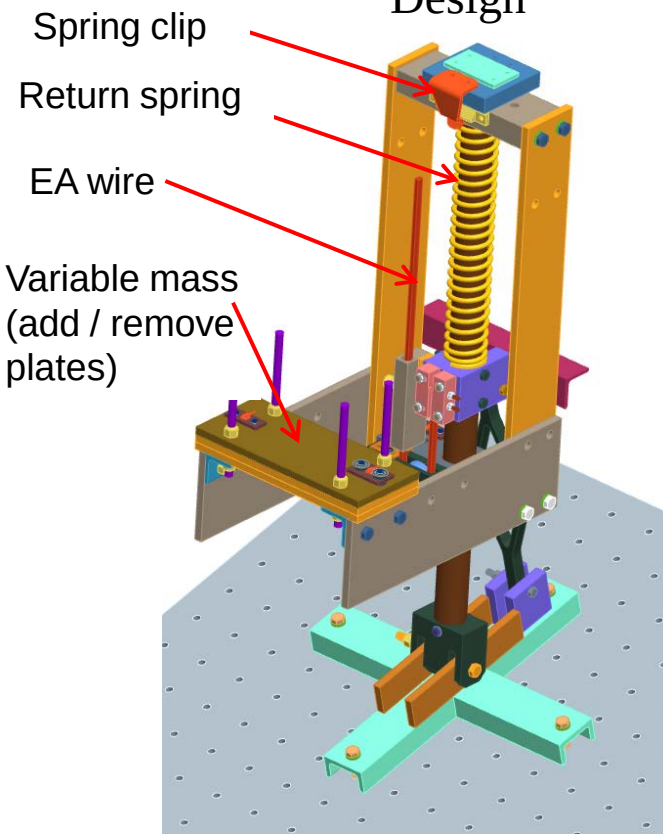
Seat is designed to function nominally with up to ±10º rotation of one mounting foot relative to the other in any direction.



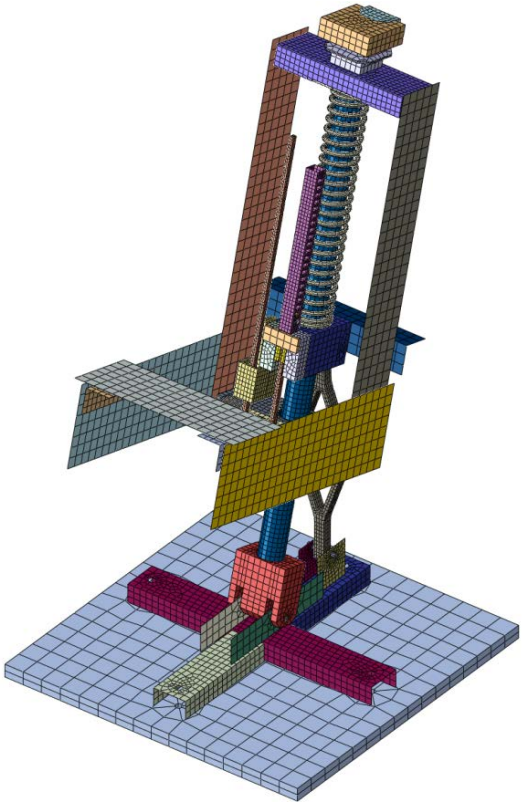
Subscale EA Test Fixture

Purpose: To test all critical energy attenuation components on the TARDEC drop tower without incurring the cost of building a complete seat.

Design



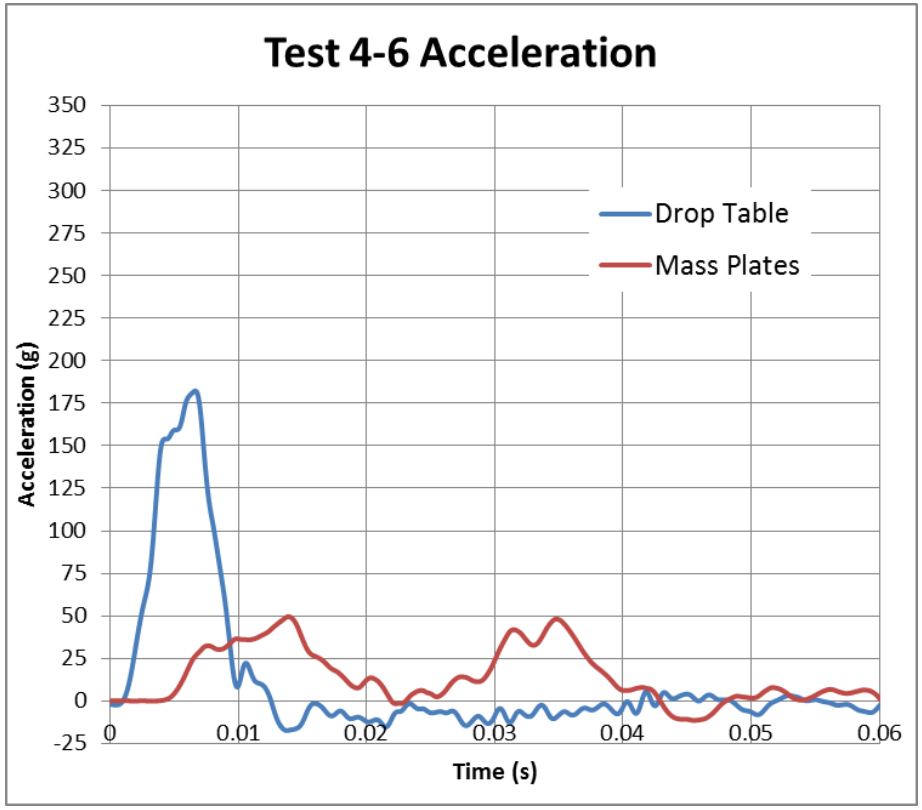
Analyze



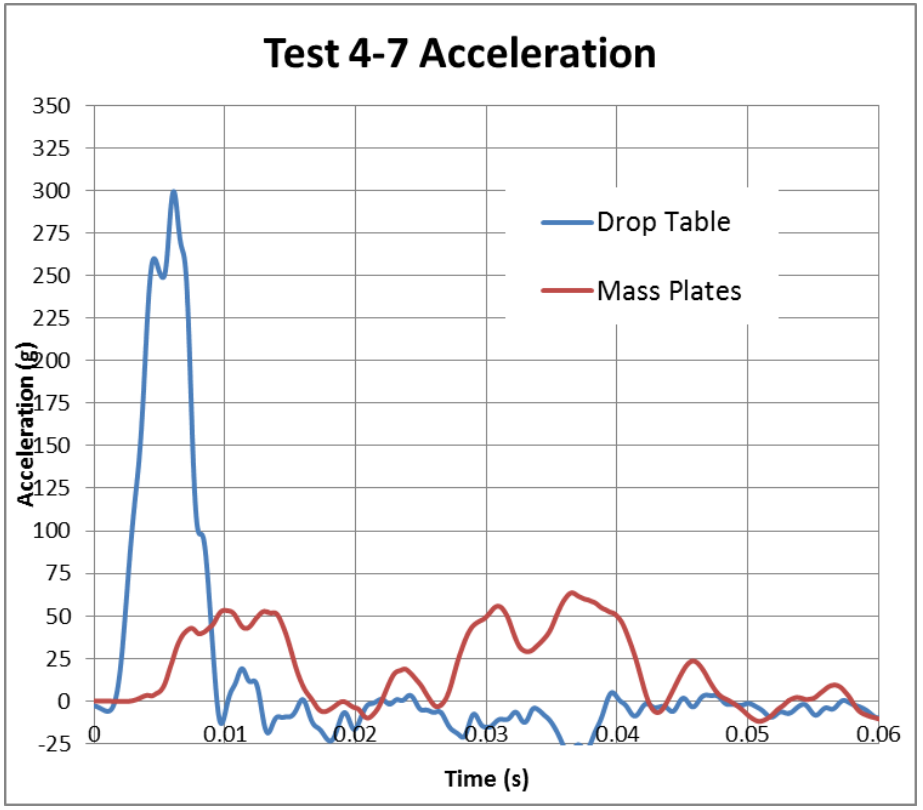
Test

Subscale EA Test Fixture Results

7 mass plates (represents 276 lb occupant),
182.3g input pulse
49.6g max on mass plates

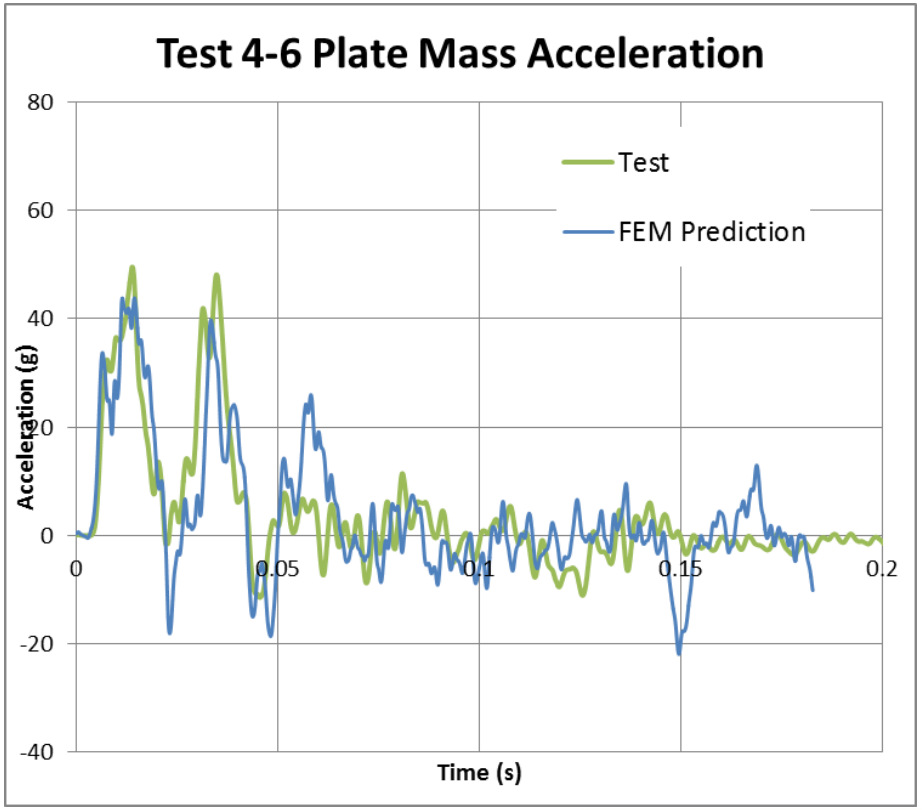


7 mass plates (represents 276 lb occupant),
299.5g input pulse
63.6g max on mass plates

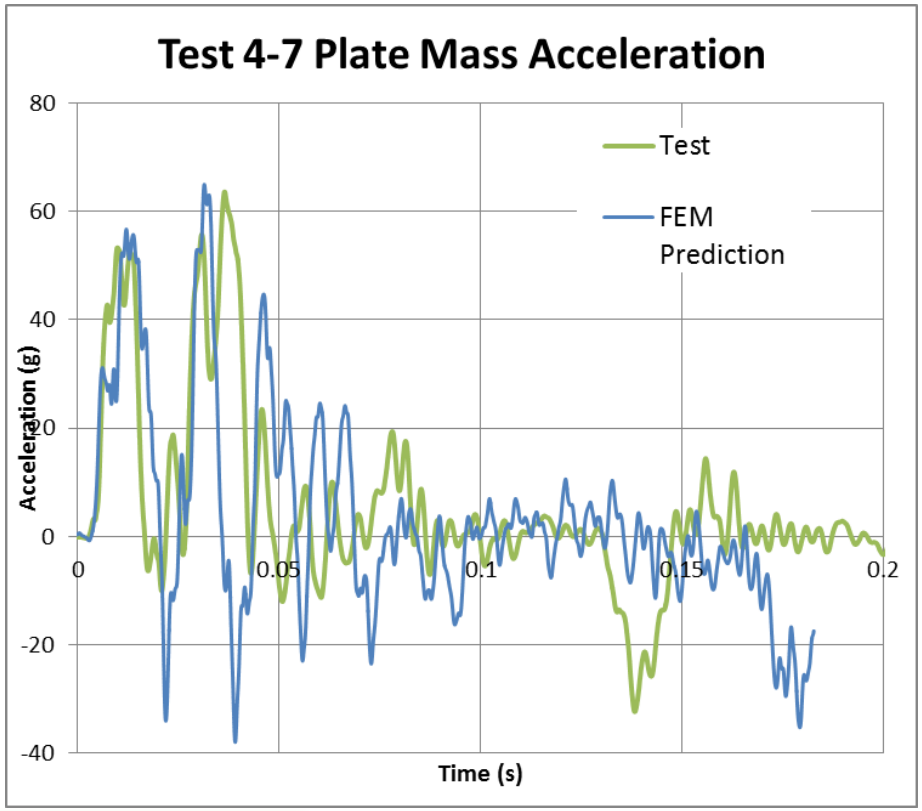


Test Results vs FEM Predictions

7 mass plates (represents 276 lb occupant), 182.3g input pulse



7 mass plates (represents 276 lb occupant), 299.5g input pulse



GOOD CORRELATION!

Subscale Test Summary Achievements Phase I Wrap Up

- The EA wire bender design worked exactly as intended. No issues were observed with the roller or EA wire.
- The ability for this design to provide protection for two equivalent impact events was clearly demonstrated at both the 200g and 325g impact levels. (Seat was dropped twice in a row without modifying or replacing EA wire).
- The spring return and ratchet mechanism worked very well throughout the testing.
- Typically the seat was reset and ready for a second hit approximately 0.2 sec after the initial impact.
- The breakout spring clip functioned as intended. It was shown that the spring clip could be re-engaged after the first hit, thus providing identical performance for the second hit.

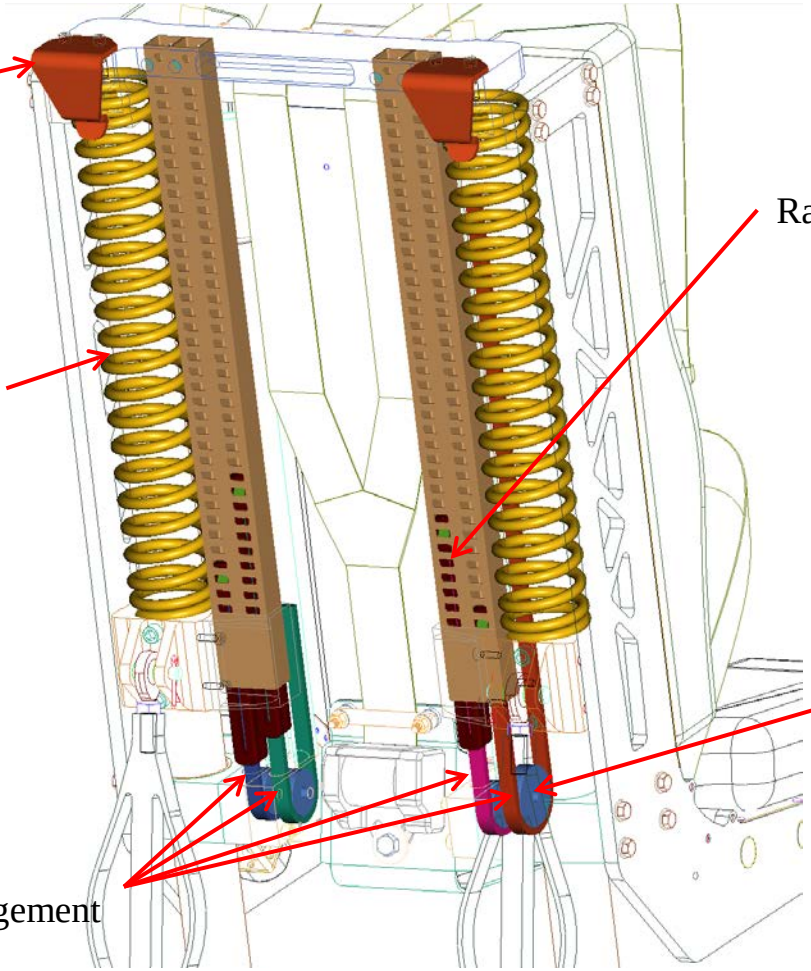
Subscale Test Summary Achievements Phase I Wrap Up

- The seat design was able to provide shock mitigation when the drop table was rotated 15º forward and aft to simulate offset loading.
- The dynamic frictional properties of various coatings were evaluated, providing excellent data for future design activities.
- The test fixture survived 30 drop tests with minimal damage. This clearly demonstrates the robust nature of the design approach.
- FEA model predictions were validated, providing a correlated analysis tool for future design studies.

Phase II design updates

- Updated design to improve seat performance for full occupant range from 5th% female (108 lb) through 95th% male + 100 lb gear (323 lb).
  - Updated EA system to utilize a total of four (4) bend wires
  - Each EA wire engages at a different point during the stroke
  - Performed over 50 analysis iterations to optimize design
- Optimization of flexible link design
- Finalized restraint system / interface
- Numerous manufacturability improvements

Phase II – EA System



Other Completed Phase II tasks

- Performed preliminary Design Failure Modes and Effects Analysis (DFMEA)
- Performed FEA of crash loads per FMVSS standards
- Documented all structural analysis and DFMEA in the “Design Analysis Report” deliverable document
- Generated drop tower test plan, provided in the “Demonstration Plan for Occupant Seat” deliverable document
- Updated drawing package to reflect latest design

Seat Fabrication – Currently Ongoing

Remaining Work

- Complete fabrication of four (4) seats
  - Estimated completion date: 15 August 2012
- Perform drop tower testing using TARDEC drop tower located at Selfridge Air National Guard Base
  - Late August / Early September 2012
- Perform vehicle or “generic hull” blast testing with seats
  - Blast testing is a complex event that requires input and hardware from many different organizations outside the control of CTC. It is possible that this testing will be scheduled outside this contract’s performance deadline.
- Evaluate test results and generate final report
  - Will be complete by November 2012

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